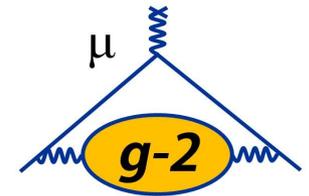


Extension Upgrade to the Muon $g-2$ Electrostatic Quadrupole System

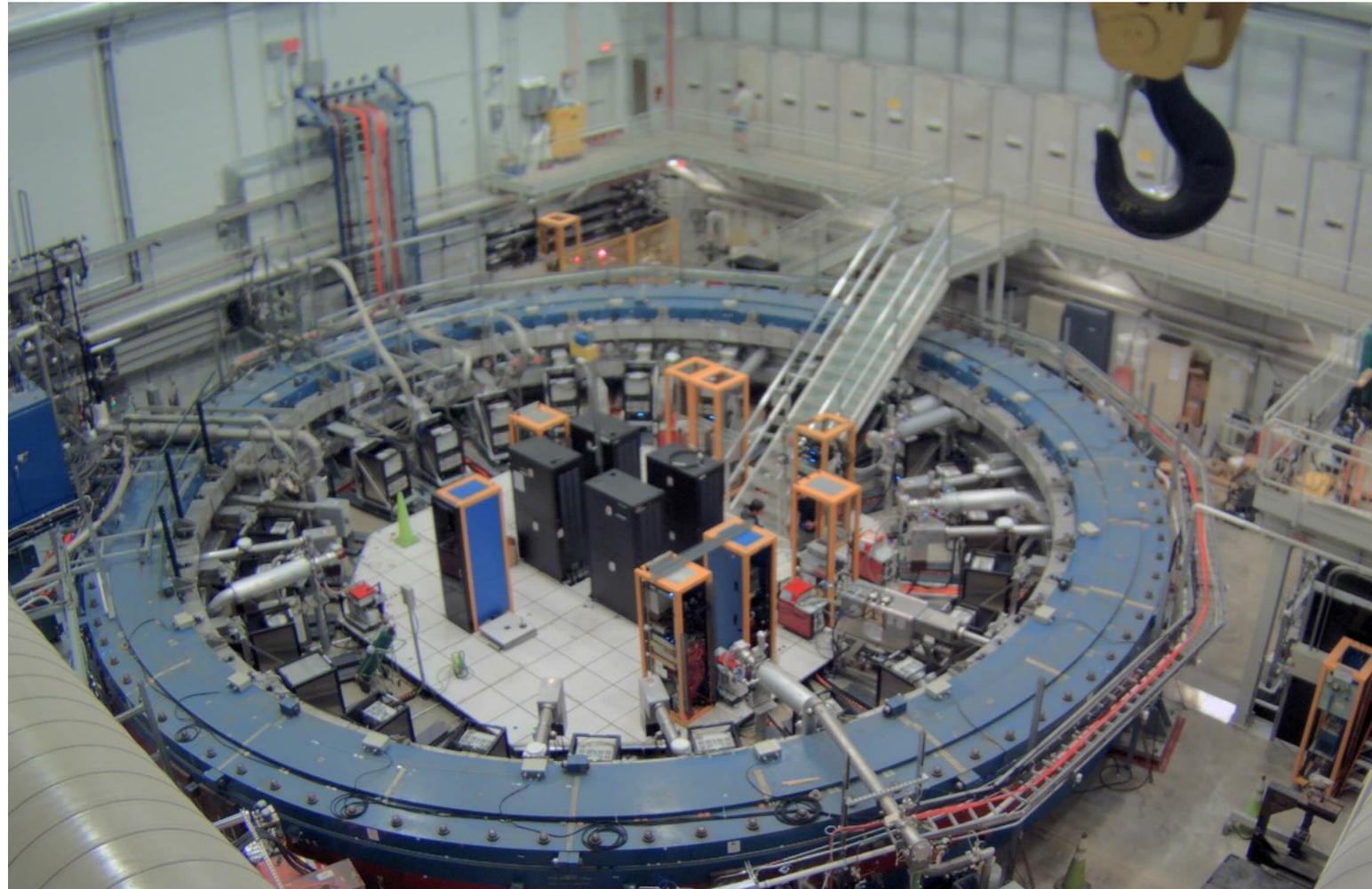


Esra Barlas

Jason D. Crnkovic, Hogan Nguyen, Wanwei Wu,
Vladimir Tishchenko, William Morse, Erik Ramberg, Mete Yucel

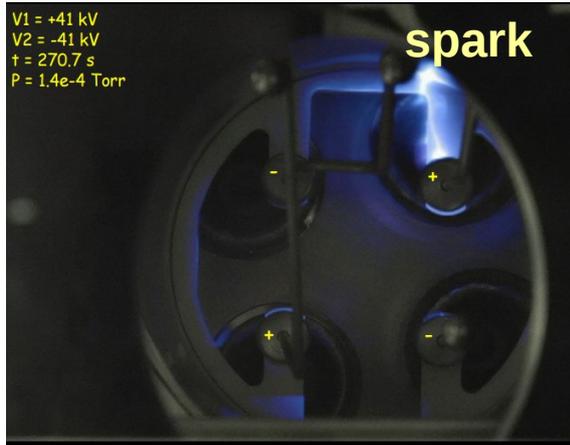
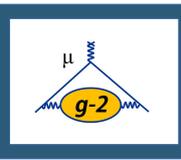


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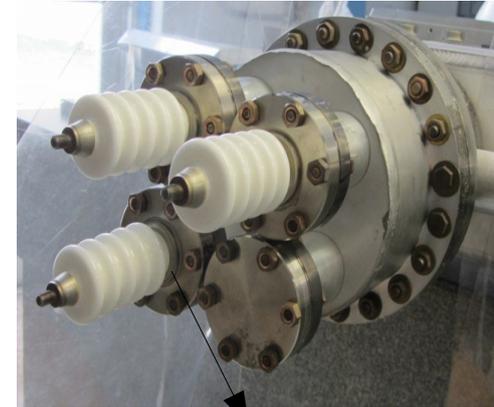


Quadrupoles

- **Four electrostatic quadrupoles**
- **4 HV Pulsers**
- **Vertically focusing the muons in storage ring.**
- **25kV(E821)→ 35kV (E989)**



- ## Reasons to upgrade
- Prevent damage to the HV feedthrough from sparks
 - Reduce sparking in the HV feedthrough box



Old feedthroughs damaged and exposed metal...



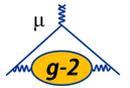
No damage at batman



New feedthroughs, no exposed metal parts

August 2016 old HV box test with new feedthroughs

Sparks!



Trapped free electrons (E,B)



charge avalanche

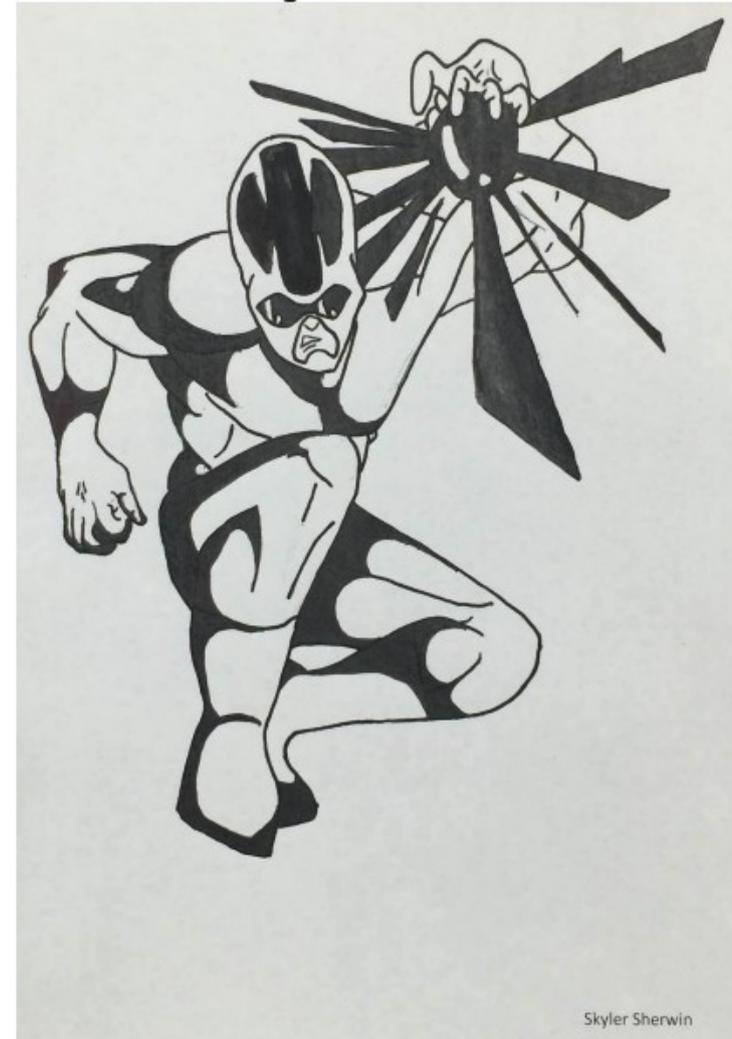


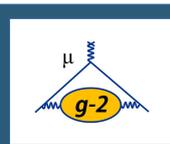
discharging quads(spark)

Do not want to direct the electrons into the MACOR insulators

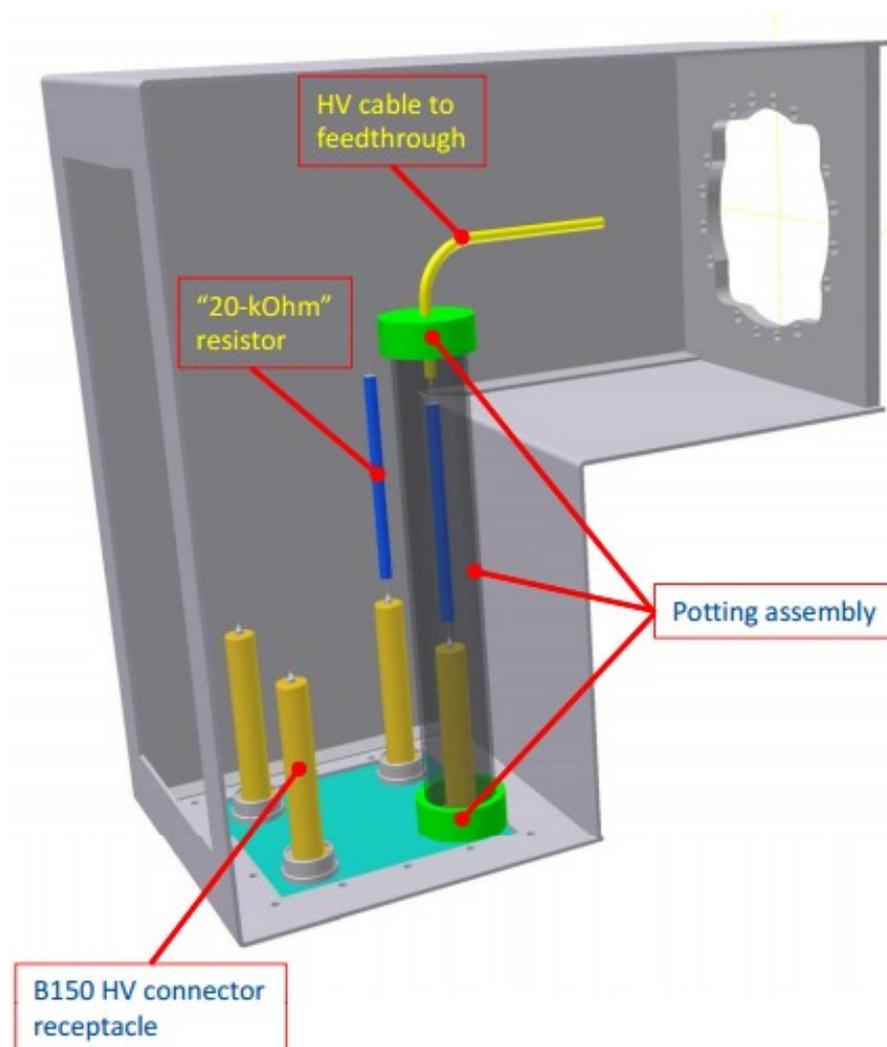


Reduce B → extend high voltage feedthrough away from magnet.

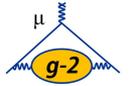




- **Moving the feed through boxes away from magnet**
→ **Extensions.**
- **Need end-connector support**
→ **Using second batman in the other side (support the extensions).**
- **Reduce sparking near resistors**
→ **Potting the resistors.**

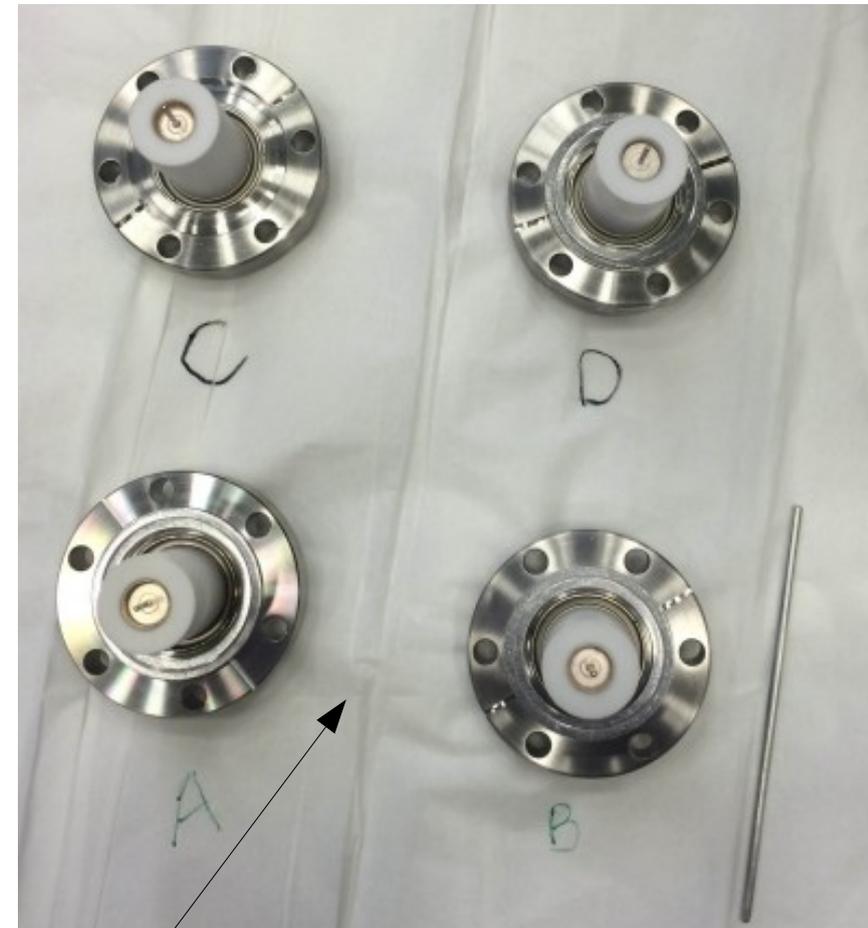


Test with Extensions(September 2016)



Test:
Two pulsers operating
at 24-32 kV, field is ON

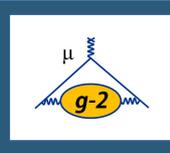
Prototype design for test



Result:

- ✓ **Extended HV feedthrough flange prevented damage to the HV feedthroughs.**

Potting the HV resistors

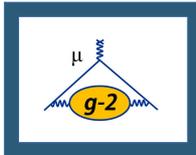


Setup for potting the resistors

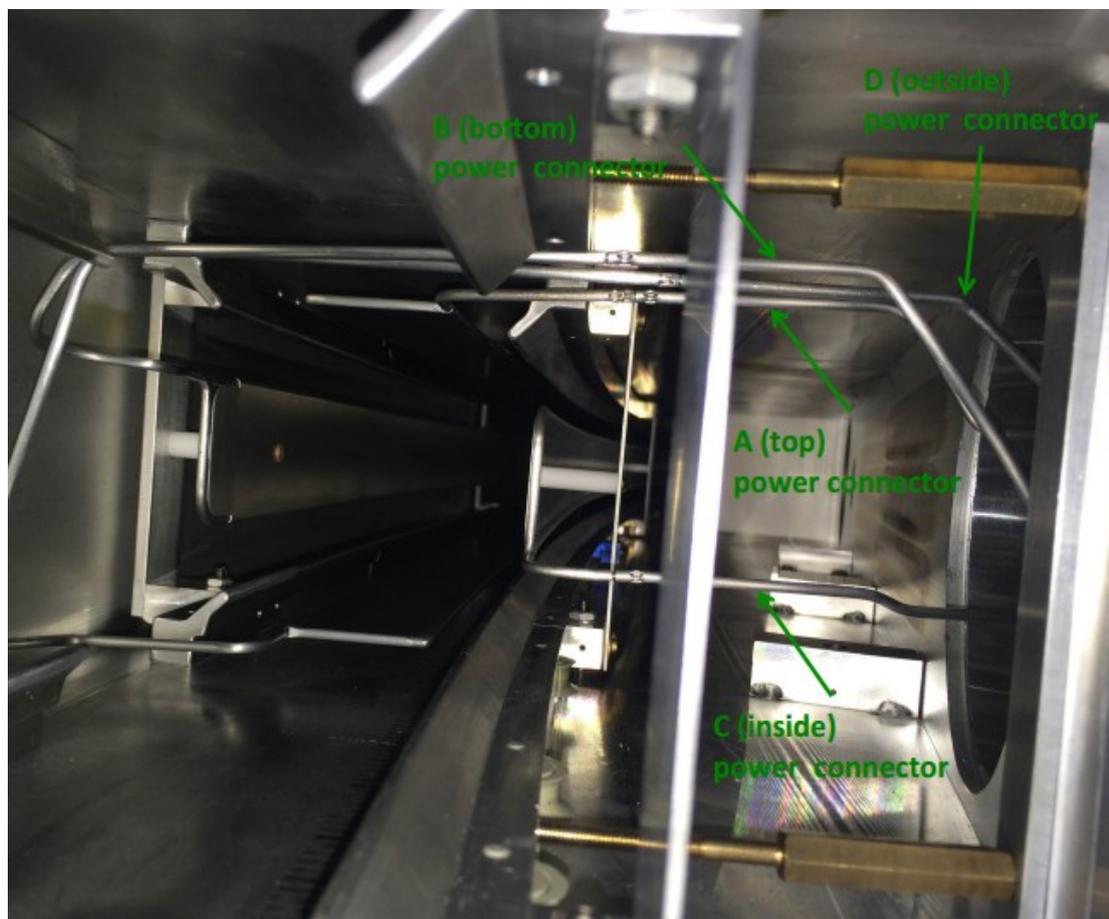
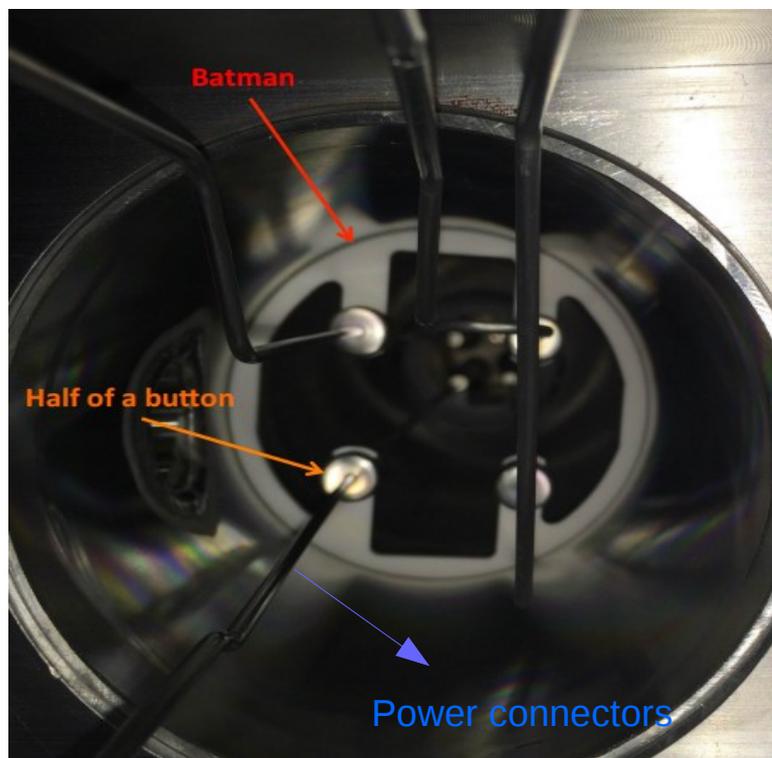


- Prime all surfaces which will be in contact with epoxy except the metal parts(RTV)
- Install the resistor into tube and the receptacle.
- Install the HV resistor assembly under the vacuum belljar.
- Degas the epoxy in vacuum belljar.
- Use degassed epoxy to pot the resistor under vacuum.

33 resistors (1 for spare) were potted in 24 days.

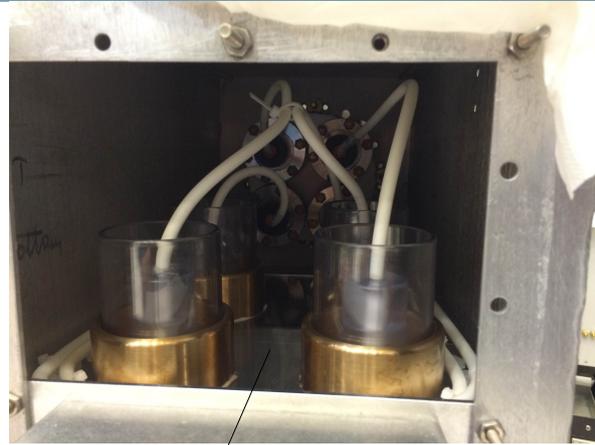
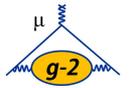


- **Batman** → Supports the power connectors.

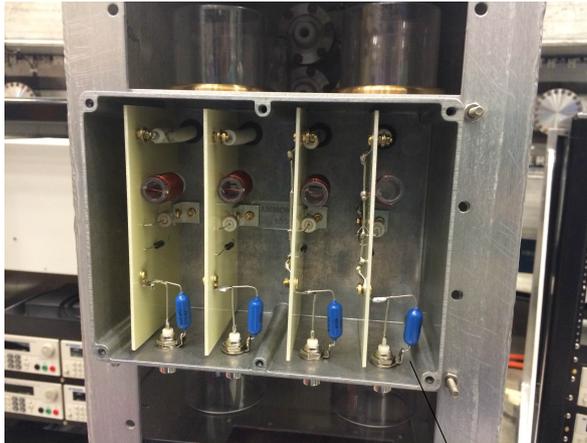


- ✓ **Have to careful about distance between leads.**
- ✓ **Leads can not get in the way of trolley.**

Installation of the HV feedthrough extension - 2

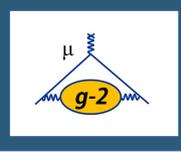


Potted resistors



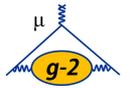
Spark detection: Readout electronics measure the change on voltage across HV resistors.

Installation of the HV feedthrough extension - 2

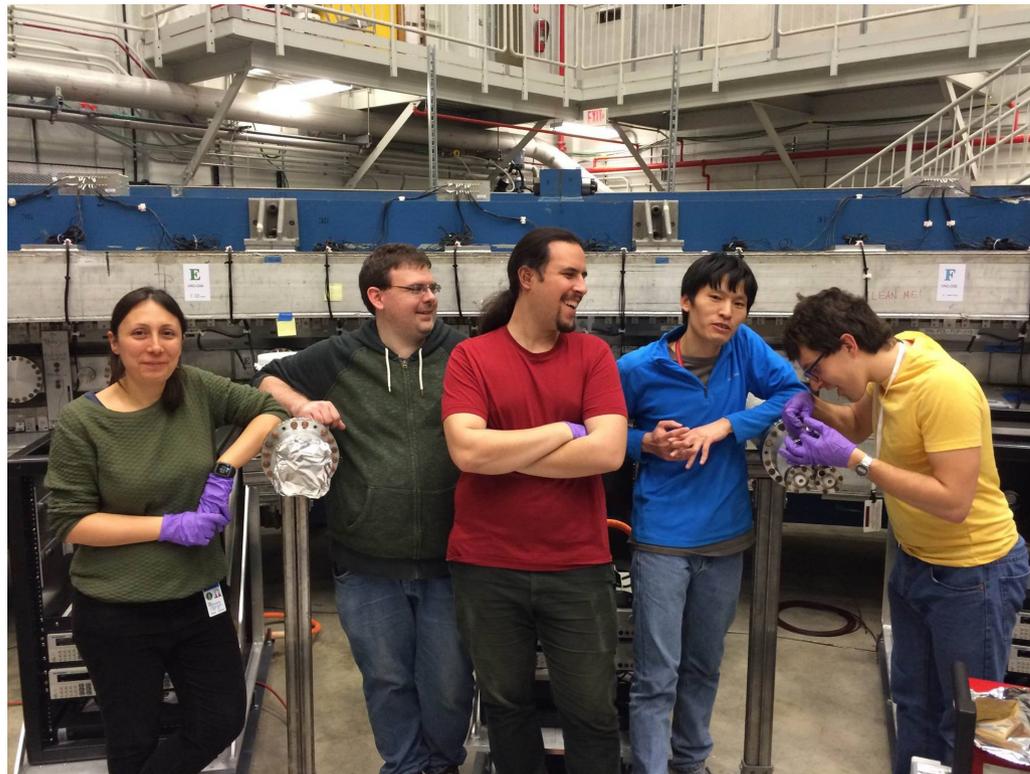


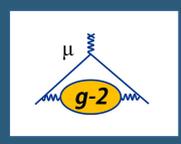
Without electronics measure the change on resistors.

Conclusion

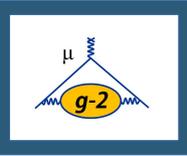


- ✓ **All 32 resistors were potted during April.**
- ✓ **All of the quad extensions were installed last month (8-16 hours each).**
- ✓ **Quads have been conditioned till then.**
- ✓ **They are operating at 11-15 kV during the commissioning.**
- ✓ **Upgrading seems to be working successfully.**





Thanks!



- J. D. Crnkovic, Designing an extension of the high voltage feedthrough flange, docdb no: 4295
- Vladimir Tishchenko, Quads: Feedthrough Box, docdb no : 3595
- Vladimir Tishchenko, Electrostatic Quadrupole Developments, docdb no: 2347
- J. D. Crnkovic, Initial gap field test of the Quad HV Feedthroughs, docdb no: 4069
- Esra Barlas, Potting and Installing the HV resistors, docdb no : 5895
- Vladimir Tishchenko et al, Potting HV resistors summary, docdb no: 5236
- J. D. Crnkovic, Quad HV Testing Update.
- Eric Schmidt et al, Charged Particle Tracking Near High Voltage Leads in Vacuum Pipe.